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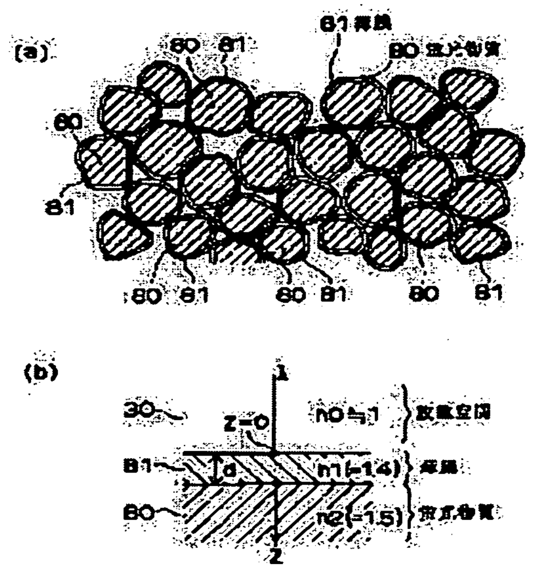
(54) PLASMA DISPLAY PANEL

(57)Abstract:
PURPOSE: To heighten the brightness of display, improve the visibility and color reproductivity by coating individual phosphor substances with a thin film of a light transmissive substance with smaller refractive index than those of the phosphor substances.
CONSTITUTION: A thin film 81 for a phosphor substance 80 is made of a light transmissive substance whose refractive index n1 is smaller than the refractive index n2 of the phosphor substance 80 (n1<n2) and which has small adsorption of displaying light. By properly setting the film thickness (d) of the thin film 81, the transmittance of ultraviolet rays impinging on the phosphor substance 80 increases and excitation efficiency is heightened and at the same time the transmittance of the displaying light with blue color radiated to a discharge space 30 from the phosphor substance 80 also increases and due to these effects, blue light emission intensity can be increased.



CLAIMS

[Claim(s)]
[Claim 1]A plasma display panel which is a plasma display panel (1) with a fluorescent substance layer (28B) which consists of many granular fluorescent substances (80), and is characterized by coming to cover said each fluorescent substance (80) with a thin film (81) of a translucency substance whose refractive index is smaller than it.

[Claim 2]The plasma display panel according to claim 1 characterized by coming to set thickness of a thin film (81) of said translucency substance as a value in which transmissivity of ultraviolet rays which excite said fluorescent substance increases.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]This invention relates to a plasma display panel (PDP) with the fluorescent substance layer for foreground-color conversion.
[0002]PDP is an advantageous self-luminescence type display device on visibility.
Since enlargement and a high-speed display of a screen are possible, it is observed as a thin display device which replaces CRT.
The use is being expanded to the field of the television image in which plane discharge type PDP which performs a full color display especially with a fluorescent substance contains Hi-Vision.
[0003]
[Description of the Prior Art]As PDP of structure suitable for the display of the specific color (multiple color and FURUKARA are included) by a fluorescent substance, plane discharge type PDP of AC drive form is known.
[0004]For example, plane discharge type PDP of 3 electrode structures has address electrode A arranged so that it might intersect perpendicularly with the electrode pair 12 which consists of the display electrodes X and Y of the couple by which adjacent arranging was mutually carried out in parallel on one substrate 11 like drawing 1 in which the example of this invention is shown, and the electrode pair 12. A plane discharge cell (main stroke cell of a display) is demarcated with the display electrodes X and Y, and the address discharge cell for choosing lighting of the unit luminous region EU or astigmatism light by one display electrode Y and address electrode A is demarcated.
[0005]A fluorescent substance layer is provided so that the inner surfaces of the substrate 21 of another side including address electrode A may be covered, it is excited by the ultraviolet rays produced in the plane discharge between the display electrodes X and Y, and emits light.
[0006]When performing a full color display, what is called the trichromatic fluorescent substance layers 28R, 28G, and 28B of R (red), G (green), and B (blue) are matched to each pixel (dot) EG which constitutes a display screen. Usually, each fluorescent substance layers 28R, 28G, and 28B are formed by applying in order the phosphor paste which uses the fluorescent substance of the granular predetermined luminescent color as the main ingredients, and calcinating it for every color, using screen printing.
[0007]As a fluorescent substance which Y_2O_3:Eu whose mean particle diameter is about 3 micrometers, for example is used in the former as a fluorescent substance which constitutes the fluorescent substance layer 28R of R, and constitutes the fluorescent substance layer 28G of G, For example, BaO-aluminum$_2O_3$:Mn whose mean particle diameter is about 3 micrometers was

used, and 3(Ba, Mg)O and 8aluminum$_2$O$_3$:Eu whose mean particle diameter is about 5 micrometers, for example were used as a fluorescent substance which constitutes the fluorescent substance layer 28B of B.

[0008]Let the particle diameter of each fluorescent substance be a larger value than the minimum from which the life of 10000 hours or more is acquired in respect of display quality (luminosity and color reproduction nature) in consideration of aging (degradation) by the ion bombardment at the time of discharge.

[0009]

[Problem(s) to be Solved by the Invention]By the way, as for a display, it is desirable that it is high-intensity more, and a rise in luminosity is a universal technical problem of a display device. In the color PDP, since the luminosity of B is [especially / R and G] low, When the white chromaticity (coordinates on a chromaticity diagram) obtained when the fluorescent substance layer of three colors is made to emit light with maximum luminance, respectively used PDP as an alternative device of CRT unlike the chromaticity of CRT, there was a problem that there was inconvenience in respect of color reproduction nature.

[0010]in view of such a problem, this invention is ******, and raises the luminosity of the display by a fluorescent substance, and an object of this invention is to enable the improvement in visibility, and the improvement of color reproduction nature.

[0011]

[Means for Solving the Problem]In order that PDP concerning an invention of claim 1 may solve an above-mentioned technical problem, as shown in drawing 2, It is the plasma display panel 1 with the fluorescent substance layer 28 which consists of many granular fluorescent substances 80, and comes to cover said each fluorescent substance 80 with the thin film 81 of a translucency substance whose refractive index is smaller than it.

[0012]It comes to set PDP concerning an invention of claim 2 as a value in which transmissivity of ultraviolet rays in which thickness of the thin film 81 of said translucency substance excites said fluorescent substance 80 increases.

[0013]

[Function]By covering the granular fluorescent substance 80 with the thin film 81 of a translucency substance with a small refractive index from that, reflection in the surface layer of the fluorescent substance 80 is reduced, and the transmissivity in the fluorescent substance 80 increases. If the transmissivity of the ultraviolet rays which enter into the fluorescent substance 80 increases, excitation efficiency will increase and the luminosity of a display will increase. The thin film 81 protects the fluorescent substance 80 from the ion at the time of electroluminescence, and prevents degradation of the fluorescent substance 80.

[0014]When the thin film 81 is layer structure, transmissivity serves as the maximum, when the relation of thickness [of the thin film 81] d, the refractive index n1 of the thin film 81, and the wavelength lambda of incident light is expressed with (1) type. And it becomes the maximum when the relation between the refractive index n of the thin film 81 and the refractive index n2 of the fluorescent substance 80 is further expressed with (2) types.

[0015]

[Equation 1]

$$d \times n1 = (2m+1)\lambda / 4 \quad \cdots (1)$$

ただし、mは任意の整数

$$n1 = \sqrt{n2} \quad \cdots (2)$$

[0016]

[Example]The exploded perspective view and drawing 2 in which the structure of the portion corresponding to EG 1 pixel of PDP1 which drawing 1 requires for this invention is shown are an expanded sectional view showing typically the structure of the blue fluorescent substance layer 28B.

[0017]Like drawing 1, PDP1 is plane discharge type PDP which has 3 electrode structures

corresponding to the unit luminous region EU of a matrix display in the display electrodes X and Y of a couple, and address electrode A, and is called a reflection type on the classification by the arrangement forms of a fluorescent substance.

[0018]The display electrodes X and Y for plane discharge are formed on the glass substrate 11 by the side of the display surface H, and are covered with the dielectric layer 17 for AC drive which maintains discharge using wall charge to the discharge space 30. MgO film 18 about thousands of A thick is formed in the surface of the dielectric layer 17 as the protective film.

[0019]Since the display electrodes X and Y are arranged to the discharge space 30 at the display surface H side, in order that they may make plane discharge wide range and may make protection from light of display light the minimum, they comprise the transparent conducting film 41 with wide width which consists of Nesa membranes etc., and the bus metal membrane 42 with narrow width with which the conductivity is compensated.

[0020]On the other hand, address electrode A for making the unit luminous region EU emit light selectively is arranged at constant pitch so that it may intersect perpendicularly with the display electrodes X and Y on the glass substrate 21 by the side of the back. When thick film processing is used for formation of address electrode A, the thickness of address electrode A is about 5-15 micrometers.

[0021]Between each address electrode A, the septum 29 of stripe shape with a height of about 100-150 micrometers is formed, and the discharge space 30 is divided by this for every unit luminous region EU in a line direction (extending direction of the display electrodes X and Y), and the gap size of the discharge space 30 is specified.

[0022]To the glass substrate 21, so that the inner surfaces by the side of the back including the upper surface of address electrode A and the side of the septum 29 may be covered, The trichromatic fluorescent substance layers 28R, 28G, and 28B of R (red), G (green), and B (blue) are formed by spreading of the paste by screen printing etc., and subsequent calcination. The thickness of a wrap portion is about 20 micrometers about the upper surface of address electrode A in each fluorescent substance layers 28R, 28G, and 28B.

[0023]Such a fluorescent substance layer is excited by the ultraviolet rays (wavelength of lambda= 147 nm) which the discharge gas in the discharge space 30 releases at the time of plane discharge, and emits light. Discharge gas is the penning gas which mixed the xenon (1 to 15% mol grade) to neon.

[0024]In the display surface H, each pixel EG comprises the three unit luminous regions EU of the identical area on a par with a line direction, and one color of fluorescent substance layers 28R, 28G, and 28B are matched at a time by each of these three unit luminous regions EU. Since discharge is local, the portion corresponding to each unit luminous region EU in the fluorescent substance layers 28R, 28G, and 28B can be made to emit light selectively, although the fluorescent substance layers 28R, 28G, and 28B of each color are following the extending direction of address electrode A.

[0025]After storing up wall charge in the unit luminous region EU selected according to display information by the write-in address method or the elimination address method when displaying, a maintaining-a-discharge voltage pulse is impressed to the display electrodes X and Y by turns. Thereby, in the unit luminous region EU which has wall charge, whenever it impresses a pulse, plane discharge arises, and the fluorescent substance layers 28R, 28G, and 28B of a predetermined color emit light. At this time, by selecting suitably the combination of the fluorescent substance layers 28R, 28G, and 28B made to emit light, a multicolor display can be performed and a full color display becomes possible by performing gradation control of the luminosity of each fluorescent substance layers 28R, 28G, and 28B further.

[0026]Now, the fluorescent substance layer 28B which emits the display light of a blue region comprises the granular fluorescent substance 80 of a large number covered with the thin film 81 of translucency, respectively like drawing 2.

[0027]The fluorescent substances 80 are 3(Ba, Mg)O and 8aluminum$_2$O$_3$:Eu, for example.

The refractive index n2 is 1.42 to about 1.52.

As for the thin film 81, the refractive index n1 becomes smaller (n1<n2) than the refractive index n2 of the fluorescent substance 80 from a translucency substance with little absorption of

display light, for example, a silicon dioxide, magnesium fluoride, alumina, etc. As a formation method of the thin film 81, the microencapsulation techniques, such as vacuum deposition, a dip method, a sputtering technique, and a spray method, can be used. The value possible nearest to the value (square root of the refractive index n2 of the fluorescent substance 80) which fills (2) types as the refractive index n1 of the thin film 81 is desirable.
[0028]While the transmissivity of the ultraviolet rays which enter into the fluorescent substance 80 increases from the discharge space 30 and excitation efficiency increases by selecting the thickness d of the thin film 81 suitably here, The transmissivity of the blue display light ejected from the fluorescent substance 80 to the discharge space 30 also increases, and luminescence intensity with these conjointly blue increases.
[0029]That is, when raising the transmissivity of ultraviolet rays so that clearly from (1) type if the wavelength lambda of 1.4 and ultraviolet rays shall be 147 nm the refractive index n1 of the thin film 81, the optimum value du of the thickness d of the thin film 81 is odd times the 26.25 (=147/4/1.4)nm. On the other hand, if luminous wavelength lambdaB of the fluorescent substance 80 shall be 450 nm, when raising the transmissivity of display light, the optimum value db of the thickness d of the thin film 81 is odd times about 80.36 (=450/4/1.4).
[0030]Then, what is necessary is just to let the least common multiple of the optimum value du and the optimum value db be a value of the thickness d. However, it is not necessary to consider it as the least common multiple strictly, and what is necessary is just both the optimum values du and a value near db. For example, what is necessary is just to set the value of the thickness d to 78.25(=26.25x3)**80.36, when it gives priority to the transmissivity of ultraviolet rays. What is necessary is just to set the value of the thickness d to 80.36 (**26.25x3), when it gives priority to the transmissivity of display light conversely.
[0031]In the case of the vertical incidence shown in drawing 2 (b), energy transmittance pi is approximately defined like (3) types.
[0032]
[Equation 2]

$$\Pi = \frac{n2}{n0} \left| \frac{2 \cdot n0}{n0[M_{11}(Z) + M_{12}(Z)\, n2] + M_{21}(Z) + n2\, M_{22}(Z)} \right| \cdots (3)$$

n0 ：放電空間３０の屈折率
n1 ：薄膜８１の屈折率
n2 ：蛍光物質８０の屈折率
$M_{ij}(Z)$ ：次の特性行列Ｍ（Ｚ）における各行列要素

$$M(Z) = \begin{bmatrix} \cos(k\, n1 \cdot Z) & -\frac{1}{n1} \sin(k\, n1 \cdot Z) \\ -i\, n1 \sin(k\, n1 \cdot Z) & \cos(k\, n1 \cdot Z) \end{bmatrix}$$

$$k : \omega / c = 2\pi / \lambda$$

[0033](3) A luminosity rise of each fluorescent substance 80 by the thin film 81 covering the blue fluorescent substance 80 in the calculation based on a formula is about 4.5%. However, although it changed actually depending on the thickness of the fluorescent substance layer 28, a state of condensation and rarefaction, and arrangement forms, not less than 15% of luminosity rise was able to be attained as the fluorescent substance layer 28 whole.
[0034]In an above-mentioned example, although the example which consists of the fluorescent substance 80 which the blue fluorescent substance layer 28B covered with the thin film 81 was shown, the rise in luminosity by the thin film 81 may be performed also with the red and green fluorescent substance layers 28R and 28G. In that case, if red wavelength is 620 nm, green wavelength is 520 nm and the refractive index n1 is set to 1.4, If thickness d of the thin film 81 shall be set to 105(**620/4/1.4)nm which is 4 times 26.25 about the red fluorescent substance layer 28R and the thickness d of the thin film 81 shall be 105 nm also about the green fluorescent substance layer 28G, Transmissivity of ultraviolet rays can be made into the maximum, and ejection of display light can be increased as much as possible.

[0035]This invention is applicable to other PDP(s) of various kinds of which perform monochrome or a multicolor display not only by the color PDP of a matrix display method but by a fluorescent substance layer.
[0036]
[Effect of the Invention]According to this invention, the luminosity of the display by a fluorescent substance can be raised and improvement in visibility and the improvement of color reproduction nature can be aimed at by it.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is an exploded perspective view of PDP concerning this invention.
[Drawing 2]It is an expanded sectional view showing the structure of a fluorescent substance layer typically.
[Description of Notations]
1 PDP (plasma display panel)
28B Fluorescent substance layer
80 Fluorescent substance
81 Thin film

[Translation done.]

* NOTICES *

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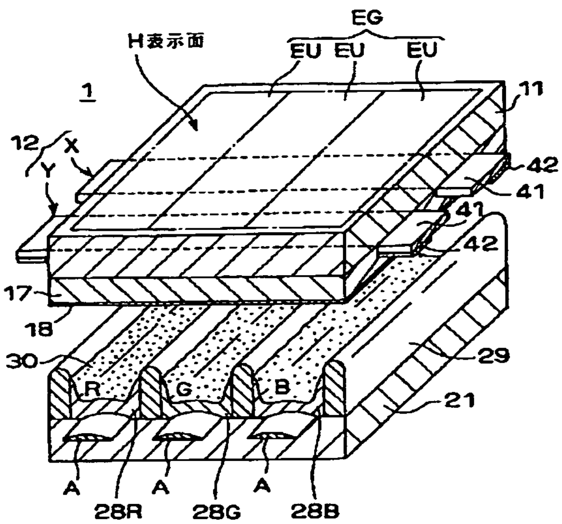
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

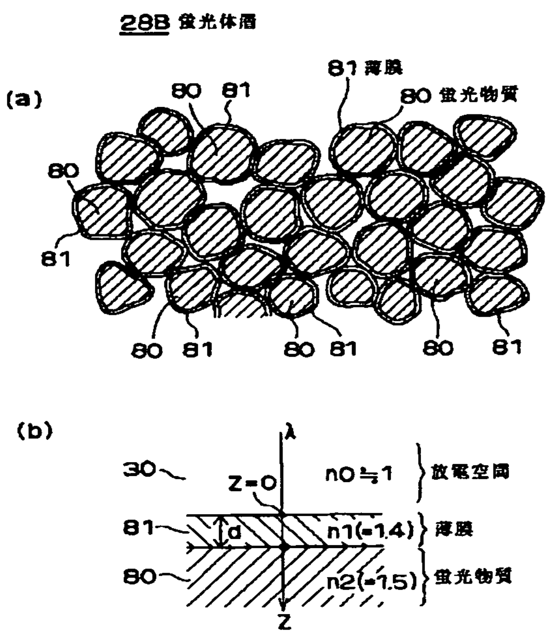
[Drawing 1]

本発明に係るPDPの分解斜視図



[Drawing 2]

蛍光体層の構造を模式的に示す拡大断面図



[Translation done.]